Research Proposal Form of the Thesis Entitled

Comparative evaluation of Calcium Sodium Phosphosilicate and light cured Ormocer based desensitizer on dentinal tubule occlusion: A Scanning electron microscopic study.

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By

Dr. Surabhi Joshi
Research Scholar
Reg. No: 202201010

Karnavati School of Dentistry

Under the Guidance
Of

Dr. Neelam Makwana (Guide)
Professor
Head - Karnavati Scientific Research Centre

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Karnavati University, Gandhinagar

Introduction

Toothache has been a major problem for humans for thousands of years. The earliest management of such pain was possible through herbal medicines and some naturally occurring salts. Over a period of time, better ways emerged with a better understanding of the physiological causes of dental pain and more measured ways of treating it.[1]

A kind of toothache that is not always due to pathology is dentine hypersensitivity, which can be very annoying and discomforting to the patient. Many studies show that the prevalence of dentine hypersensitivity ranges from as low as 3% to as high as 74%,[2-5,] depending on the population, geography, and sometimes also due to study design.[6]

Dentine hypersensitivity occurs mainly due to two reasons: either loss of enamel due to attrition, abrasion, or other non-carious reasons, or loss of cementum due to periodontal reasons.[7-8]

According to Brannstrom's hydrodynamic hypothesis, dentinal hypersensitivity occurs due to fluid movement inside the dentinal tubules, creating pressure changes that activate pulpal nerves and cause pain. So, basically, for hypersensitivity to occur, not only must dentine be exposed, but also dentinal tubules must be open.

Therefore, an effective treatment would be to either cover the lost dentinal coverage with some restorative material or to block the dentinal tubules to prevent nerve stimulation.[9-10]

A product named NovaMin is a synthetic mineral consisting of calcium, phosphorus, sodium, and silica.[11-12] It releases deposits of crystalline hydroxyl-carbonate apatite (HCA) that bear structural resemblance to the mineral content of teeth.[13-14]

A Voco (Cuxhaven, Germany) product, Admira Protect is a light-cured Ormocer-based desensitizer (VOCO America Inc., Indian Land, South Carolina, USA) that is nontoxic and uses specific filler technology and releases fluoride [15]Admira Protect serves as a primer, causing several intratubular sealing layers to develop within the dentinal tubules via protein precipitation. Unlike fluoride-based varnishes, its method of action requires light curing to achieve efficient tubule occlusion.

Hence, the purpose of this study is to assess the efficacy of NovaMin, Admira Protect in managing dentinal hypersensitivity.

AIM:

This study aims to assess the efficacy of NovaMin, Admira Protect in managing dentinal hypersensitivity.

OBJECTIVE:

To study the effect of

a) Calcium sodium phospho silicate

b) Admira protects desensitizing agents on dentinal tubule occlusion using Scanning Electron Microscope.

2. To compare the effects of the above two commercially available desensitizing agents.

Proposed Hypothesis

Novamin and Admira Protect both will occlude dentinal tubules sufficiently and better than the control group in extracted human premolars

Admira Protect will demonstrate better and more even tubular sealing due to its Ormocer-based formulation and light-cure polymerization.

Null Hypothesis

NovaMin, Admira Protect, and the control group will all have a similar amount of dentinal tubule occlusion with no statistically significant difference.

Review of Literature

Almas and colleagues (2001) conducted a scanning electron microscopy (SEM) study to investigate the surface alterations of dentin following the application of propolis and saline. The study highlighted the need for active agents to achieve effective dentin sealing and suggested further clinical evaluation of natural desensitizing products like propolis[16]

Torwane et al. (2013) undertook a randomized, double-blind, split-mouth clinical experiment to compare the effectiveness of 30% ethanolic extract of Indian propolis with Recaldent™ (CPP-ACP) in treating dentinal hypersensitivity (DH). The study included 13 subjects from a central correctional facility and a total of 73 hypersensitive teeth. The subjects were divided into three groups: Indian propolis, Recaldent™, and sterile water as a control. Treatments were administered on days 1, 7, 14, and 21, and sensitivity was

measured using a verbal rating scale. Both Recaldent™ and Indian propolis considerably reduced DH; however, Recaldent™ had a stronger effect than propolis and the placebo[17].

West et al. (2013) conducted a randomized clinical trial to compare the short-term efficacy of two desensitizing toothpastes. The results revealed that both the toothpastes with different formulations were considerably effective in reducing dentinal hypersensitivity after the first time application, and the effect was sustained over three days [18]

Torres et al. (2014) conducted a randomized, double-blind clinical trial involving 40 patients to compare the short-term efficacy of three desensitizing agents: Admira Protect, Bifluorid 12, and Colgate Pro-Relief. Each product was applied to different quadrants of the same patient. Sensitivity was measured using tactile and air blast stimuli. The patient response was recorded using the Visual Analogue Scale (VAS) at baseline, immediately after application, and after four weeks.

All three desensitizing treatments showed a significant decrease in hypersensitivity both immediately after application and during the follow-up period. Admira Protect and Bifluorid 12 had longer-lasting desensitizing effects, remaining effective for up to four weeks (Admira Protect) and three weeks (Bifluorid 12) with tactile stimuli and four weeks with evaporative stimuli, respectively. In comparison, Colgate Pro-Relief demonstrated effective desensitization for only two weeks. The findings indicate that a single application of light-cured or fluoride-based desensitizers (Admira Protect and Bifluorid 12) gives longer-lasting relief than Colgate Pro-Relief, demonstrating their clinical utility in the short-term management of dentin hypersensitivity [19]

Chen et al. (2015) tested the efficacy of three desensitizing agents, red propolis extract (RPE), calcium sodium phosphosilicate (NovaMin), and arginine-calcium carbonate (ACC), in occluding dentinal tubules, with saline serving as a control. In this investigation, dentin discs treated with saline showed much lower tubule occlusion than those treated with active agents. The saline group served as a baseline, demonstrating the natural state of open dentinal tubules after phosphoric acid etching, with little or no occlusion seen under scanning electron microscopy. Furthermore, when exposed to an acid challenge, the saline-treated discs showed no improvement in tubule closure, demonstrating saline's incapacity to provide any protective or desensitizing benefits. These findings highlight the

importance of active therapeutic drugs in the management of dentinal hypersensitivity, as saline alone does not contribute to tubule occlusion or protection against acidic assaults.[20]

Maity et al. (2020) conducted a randomized clinical study to assess and compare the clinical effectiveness and longevity of two desensitizing agents: propolis and a light-cured ormocer-based desensitizer (Admira Protect) in reducing dentinal hypersensitivity (DH). The trial involved 13 patients with a total of 72 hypersensitive teeth, which were randomly divided into three groups: Group A received propolis, Group B was treated with Admira Protect, and Group C (control) received sterile water.[21]

Sabari Murugesan (2021) did a laboratory investigation to compare the efficacy of a propolis-based varnish to two traditional varnishes for treating dentin hypersensitivity (DH). The study used SEM to assess dentinal tubule occlusion and resistance to erosive and abrasive wear. Although MI Varnish had better dentinal tubule occlusion, Propolis Varnish had a higher resilience to material loss after acidic abrasive treatment. These data indicate that Propolis Varnish may provide advantages in long-term wear resistance, stressing the need to select varnishes with optimal performance for the clinical therapy of DH. Additional clinical validation is required to support these in vitro findings.[22]

Midha et al. (2021) used scanning electron microscopy to compare the effectiveness of four different desensitizing dentifrices on dentinal hypersensitivity. The investigation entailed preparing dentin slices from molars that were etched to open dentinal tubules before treatment. The samples were then separated into four groups and treated with toothpastes containing 5% NovaMin, Propolis, 5% potassium nitrate, and 8% arginine. After 15 days of twice-daily brushing, the degree of tubule blockage was measured using SEM. The results showed that all tested drugs strongly occluded dentinal tubules; however, 5% NovaMin was the most effective in tubule blockage, followed by arginine, potassium nitrate, and Propolis. This demonstrates that, while all of these treatments help to manage dentinal hypersensitivity, NovaMin has a higher potential due to its combination of desensitizing and remineralizing capabilities.[23]

In Palak Dwivedi's study (2022), the main goal was to assess and compare the effectiveness of a 980-nm diode laser and 2 desensitizing toothpastes in sealing tubules, a prevalent issue in dentin hypersensitivity. Employing SEM, 12 extracted premolars were sectioned into dentin discs, treated with 17% phosphoric acid to uncover tubules, and then divided into four

categories. Diode Laser application, application of SHY-XT toothpaste, Biomed toothpaste, and distilled water application (control). After treatment, SEM analysis unveiled a statistically significant difference in mean values of complete dentinal tubular occlusion among the categories. Notably, the Diode Laser (Group A) demonstrated superior occlusion to toothpaste (Groups B and C) and showed less desensitizing effect in comparison. Findings indicate that diode laser therapy proves to be more effective in dentinal tubular occlusion than the desensitizing toothpaste alternatives [24]

Sahoo's study (2023) aimed to evaluate the effectiveness of three desensitization methods in closing dentinal tubules. Utilizing 100 human premolar teeth, samples were separated into four groups: control, NaF 5% varnish, diode laser treatment, and CPP-ACP application. The findings revealed that diode laser therapy demonstrated the most substantial occlusion of dentinal tubules. While the control group displayed the least occlusion. The study concludes that while all methods were effective in tubule occlusion, diode laser treatment demonstrated a superior reduction in dentin permeability compared to the other techniques. This finding contributes valuable insights to the literature on dentin hypersensitivity management, emphasizing the potential efficacy of diode laser therapy in reducing dentinal permeability [25]

Naghsha et al. (2024) did an in vitro investigation to examine the dentinal tubule occluding effects of a propolis-based herbal toothpaste with a 5% sodium fluoride varnish. The researchers used scanning electron microscopy to quantitatively and subjectively assess the degree of tubule blockage on human premolar dentin discs. The samples were prepared by removing the cementum and smear layer before being separated into three groups: one treated with propolis toothpaste, another with sodium fluoride varnish, and one as a control. The results showed that both herbal toothpaste and fluoride varnish considerably reduced the number of open dentinal tubules compared to the control. Additionally, the propolis-based toothpaste demonstrated a significantly higher reduction in open tubules than the fluoride varnish, indicating its potential usefulness in treating dentin hypersensitivity by efficiently occluding dentinal tubules [26]

Materials & Methods

Intact extracted human premolars will be used in this study, which should fulfil the following criteria:

1. Teeth extracted for orthodontic reasons.

2. No scaling, root planing has been done in the last six months

The dentine specimens will be prepared from such sound extracted human premolars, which will be collected from the Department of Oral & maxillofacial surgery, Karnavati School of Dentistry, Uvarsad, Gandhinagar, and will be stored in 10% formalin at room temperature.

Preparation of the specimens:

Sixty dentine specimens will be prepared from the extracted teeth. After cleaning the tooth surface using an ultrasonic scaler. The teeth will be sectioned using a carborundum disc. The apical third portion and crown portion of the tooth will be removed, and dentine samples of 2mm thickness will be obtained from the remaining section.

All the 2mm thickness specimens will then be placed in an ultrasonic cleaner containing distilled water for 30 seconds. After that, all the samples will be etched using 6% citric acid for 2 minutes to remove the smear layer. Thereafter, except for the control specimens, all the samples will be treated by desensitizing agents according to manufacturer's instructions.

The specimens will then be randomly assigned to three groups:
Group 1: Surface treated with Sterile water (control)

Group 2: Calcium sodium phosphosilicate

Group 3: Admira protect

- In Group I, the therapy consists of administering sterile water (placebo). The dentinal surfaces will be properly washed to remove any dirt. The surface will be gently air-dried to remove extra moisture. Sterile water will be poured onto a disposable applicator and administered evenly to the exposed dentin surfaces.
- Test materials:
    - Group 2-Calcium sodium phosphosilicate:

In the NovaMin group, the paste will be applied to the dentin samples using a swab. After 2 minutes, it will be gently rinsed off, and the specimens will then be dried.

- Group 3 – Admira protect

  Admira Protect will be applied and spread evenly on all exposed dentin surfaces. The substance will be left alone for 20 seconds to allow for interaction with the dentinal tubules. After being softly dispersed with a mild airjet, it will be light-cured for 10 seconds with a polymerization equipment at a minimum light intensity of 500 mW/cm².

SPECIMEN PROCESSING FOR SCANNING ELECTRON MICROSCOPY (SEM) ANALYSIS:

Further processing of specimens will be conducted in Gthe EER Foundation, Indroda Park, Gandhinagar. These specimens will be fixed to a tiny stub with silver paste and then introduced into an ion-sputtering apparatus. In a high vacuum environment, ions will be released from the gold target toward the cathode (i.e., the samples). Specimens will be sputter-coated with a tiny layer of gold using a fine-coat ion sputter under vacuum conditions. This process ensures enough conductivity for the non-conductive specimens, which will then be sputter-coated with ions for 5 minutes before being examined under the scanning electron microscope.

The specimens will be analysed using a scanning electron microscope, with photos of the samples recorded using the SEM's camera. The surface of the dentine specimens will be examined under suitable magnification and photographed. Each image will be examined to calculate the number of open tubules and the number of completely occluded tubules. The tubules with either complete crystal penetration or full blockage due to salt precipitation will be considered as occluded tubules.

Statistical Analysis:

The data for each parameter will be calculated to obtain the mean and standard deviation.

A one-way Analysis of Variance (ANOVA) will be used to compare differences between the groups. ANOVA separates the total variation into between-group and within-group components. If the calculated F-value is statistically significant, it will indicate that there is a meaningful difference between the group means.

When a significant F-value is obtained, a post-hoc Least Significant Difference (LSD) test will be performed to identify which specific groups differ from each other. If the F-value is not significant, it will imply no significant difference among the groups, and post-hoc testing will not be carried out.

A P-value less than 0.05 will be considered statistically significant. All data will be analyzed using the SPSS software package.

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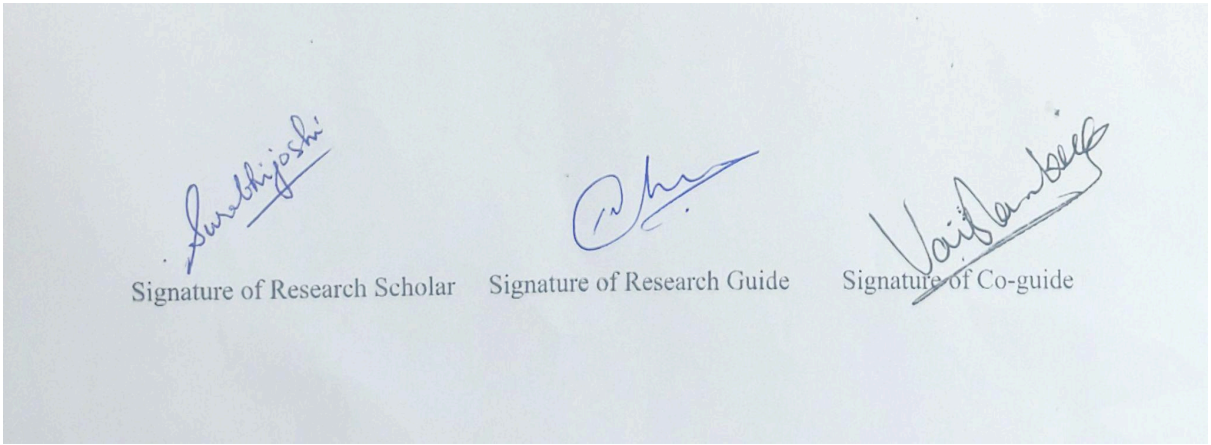
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